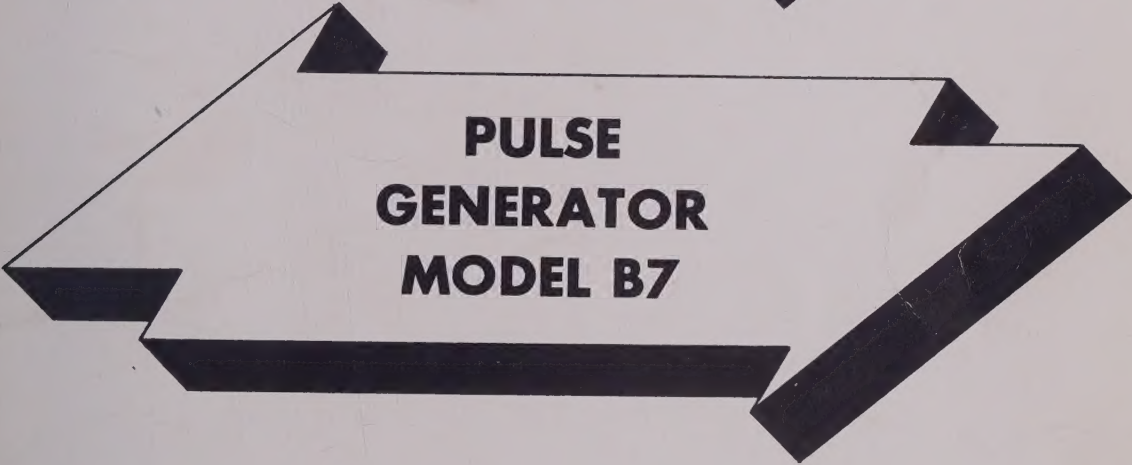


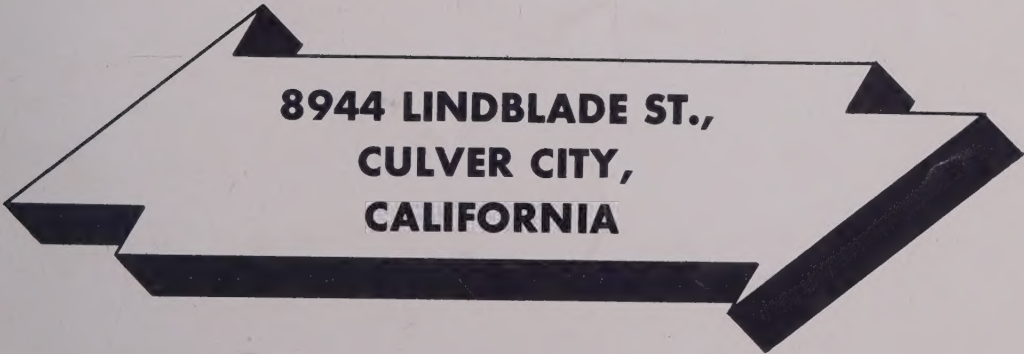


Rutherford

ELECTRONICS CO.



**PULSE
GENERATOR
MODEL B7**



**8944 LINDBLADE ST.,
CULVER CITY,
CALIFORNIA**

PULSE GENERATOR

MODEL B-7

Serial No. 872-C

Price \$5.00

Rutherford

ELECTRONICS CO.

8944 LINDBLADE STREET
CULVER CITY, CALIFORNIA

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PULSE GENERATOR

MODEL B7

GENERAL DESCRIPTION

The model B7 is a compact, lightweight, general purpose pulse generator designed to meet the rigid requirements of a great number of research and testing requirements. of Exacting design criteria, an electron tube complement of a small number of tube types, and special duty cycle limiting circuitry to automatically protect the output tubes from life shortening overloads insure long periods of reliable operation with a minimum of maintenance and repair problems.

The model B7 produces trains of 50 volt pulses having repetition rates to 2 megacycles, pulse delays and widths to 10,000 microseconds, rise and fall times of 15 millimicroseconds, and a permissible duty factor of up to 30% at full amplitude.

The model B7 generates these pulse trains in the following manner. (Refer to Fig. A for time relations of the various pulses.)

The oscillator section creates a continuous train of timing pulses to establish the repetition rate of the output pulse. These timing pulses are used to start delay circuitry to produce what we shall call a start pulse. The start pulse occurs at the end of a time predetermined by the pulse delay controls. The start pulse is used to form the leading edge of the output pulse and to start another delay circuit which produces a second pulse called the stop pulse. This stop pulse occurs at the end of a time predetermined by the setting of the pulse width controls and is used to form the trailing edge of the output pulse. A clamp tube, which is cut off at the time the start pulse occurs and back on again when the stop pulse occurs, creates what is used as a fill-in pulse between the start and stop pulses. The basic output pulse is therefore created by turning the main pulse on with the start pulse, keeping it on

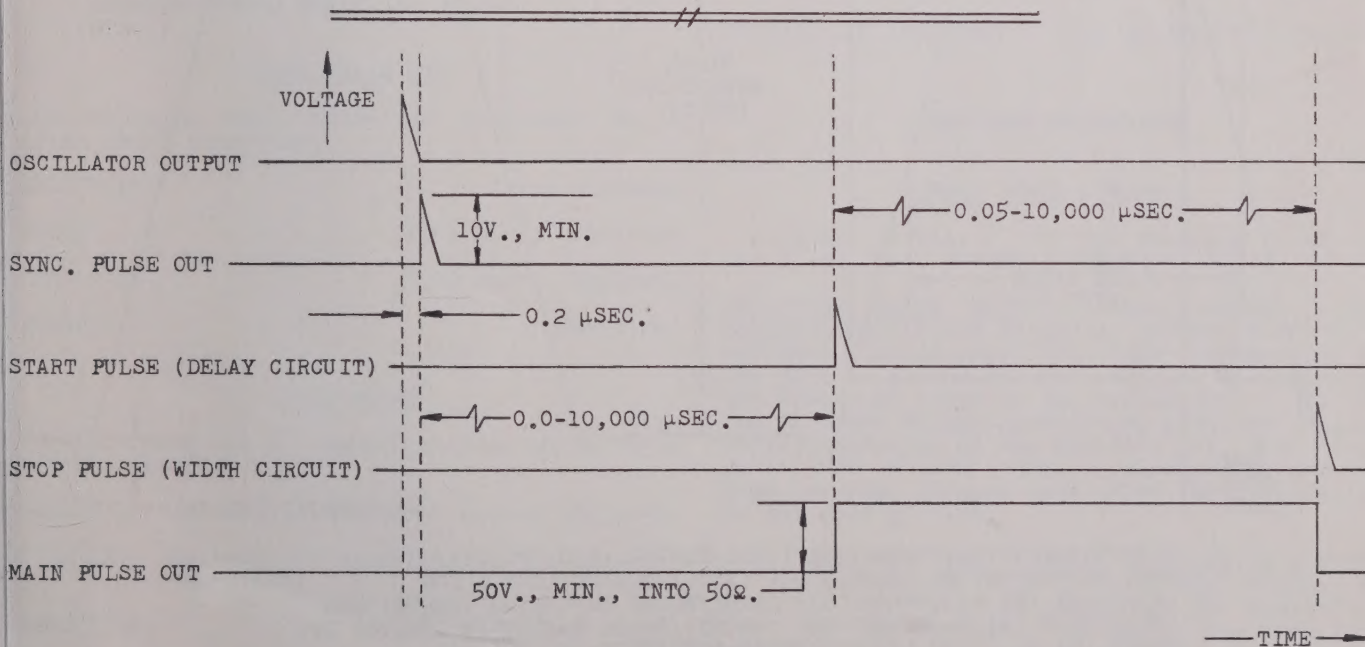


FIG. A TIMING DIAGRAM.

with the fill-in pulse, and turning it off with the stop pulse.

The pulse forming circuitry then amplifies the power of this pulse and presents it through suitable attenuation and polarity determining circuitry as the main output pulse.

Supplementary circuitry furnishes a synchronizing pulse from the oscillator section for use in synchronizing additional instrumentation with the main output pulse of the generator, a means of triggering the generator from an external source so that it may be synchronized with other instruments, and a means of varying the rise and fall times of the output pulse for applications requiring a degraded pulse shape.

Past experience has indicated confusion concerning the definition of some of the basic terminology used in reference to pulses. Fig. B shows these terms as defined by accepted IRE standard pulse terminology. When used in this manual, these terms are meant to be as defined by this standard.

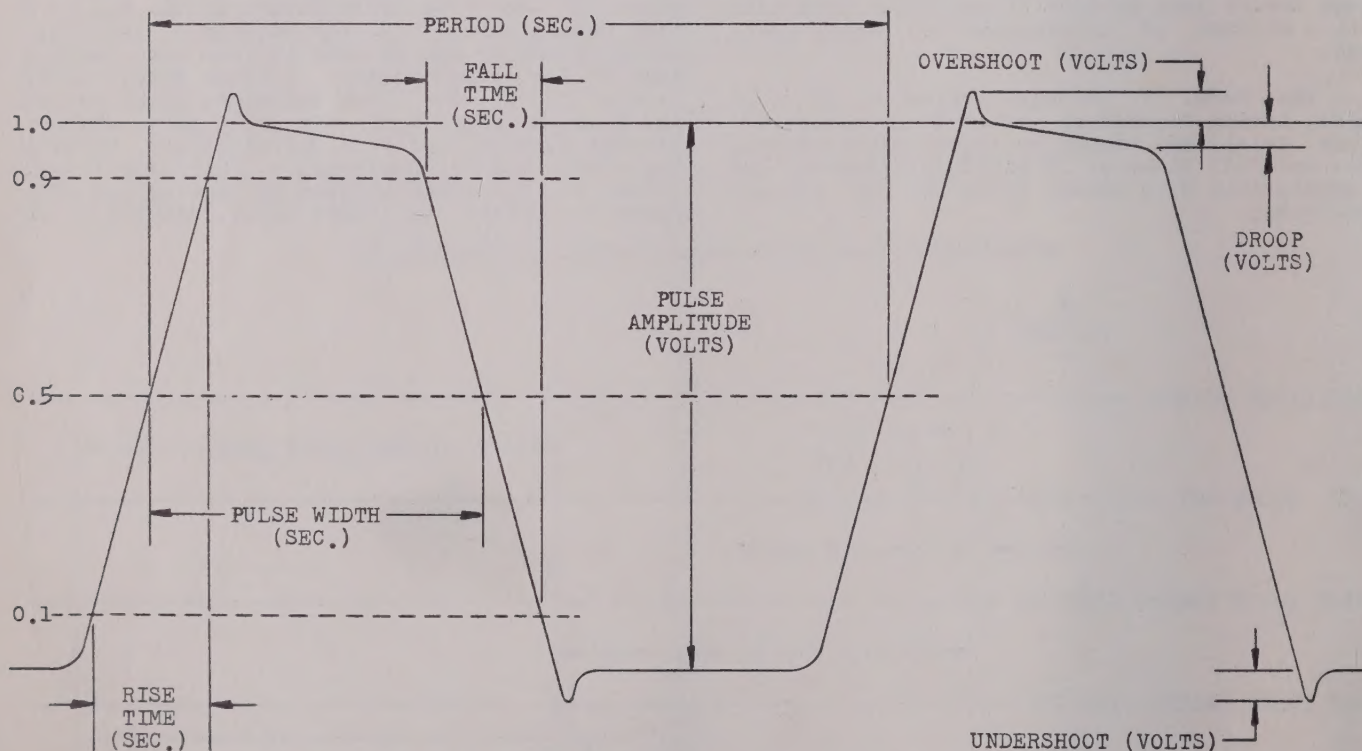
SPECIFICATIONS

The following are the design specifications of the model B7 pulse generator. The instrument will, in most cases, exhibit properties which are superior to the specification.

OSCILLATOR REPETITION RATE

The internal oscillator is continuously variable from 20 cycles per second to 2 megacycles per second in five ranges.

20 cps	-	200 cps
200 cps	-	2 kc
2 kc	-	20 kc
20 kc	-	200 kc
200 kc	-	2 mc



$$\begin{aligned} \text{REPETITION RATE (PULSES/SEC.)} &= 1/\text{PERIOD (SEC./PULSE)} \\ \text{DUTY FACTOR (\%)} &= \text{PULSE WIDTH (SEC.)}/\text{PERIOD (SEC.)} \times 100 \\ \text{OVERSHOOT (\%)} &= \text{OVERSHOOT (VOLTS)}/\text{PULSE AMPLITUDE (VOLTS)} \times 100 \\ \text{UNDERSHOOT (\%)} &= \text{UNDERSHOOT (VOLTS)}/\text{PULSE AMPLITUDE (VOLTS)} \times 100 \\ \text{DROOP (\%)} &= \text{DROOP (VOLTS)}/\text{PULSE AMPLITUDE (VOLTS)} \times 100 \end{aligned}$$

FIG. B DEFINITIONS OF BASIC PULSE TERMINOLOGY.

PULSE DELAY

Main pulse delay is continuously variable, with respect to the sync. pulse out, from 0.0 microseconds to 10,000 microseconds in five ranges.

0.0 μ sec.	-	1.0 μ sec.
1.0 μ sec.	-	10 μ sec.
10 μ sec.	-	100 μ sec.
100 μ sec.	-	1,000 μ sec.
1,000 μ sec.	-	10,000 μ sec.

PULSE WIDTH

Main pulse width is continuously variable from 0.05 microseconds to 10,000 microseconds in five ranges.

0.05 μ sec.	-	1.0 μ sec.
1.0 μ sec.	-	10 μ sec.
10 μ sec.	-	100 μ sec.
100 μ sec.	-	1,000 μ sec.
1,000 μ sec.	-	10,000 μ sec.

TRIGGER REQUIRED

To trigger the unit from an external source, the following trigger pulse is required.

AMPLITUDE	20V., minimum. *
REPETITION RATE	2 mc, maximum.
RISE TIME	1.0 μ sec. or less.
POLARITY	Positive or negative.

NOTE: At lower repetition rates and/or faster rise times, the instrument triggers with a much lower amplitude pulse.

SYNC PULSE OUT

The following sync. pulse is available at a front panel connector.

AMPLITUDE	10V., minimum.
WIDTH	0.05 μ sec., minimum.
RISE TIME	0.03 μ sec., maximum.
POLARITY	Positive.

MAIN PULSE

The following are the specifications of the main output pulse.

AMPLITUDE	50V., minimum, into a 50 Ω load.
POLARITY	Positive or negative, but not simultaneously.
RISE TIME	0.015 microseconds.
FALL TIME	0.015 microseconds.

* The fast rise time quality of the sync. pulse out allows the model B7 to be triggered from the sync. pulse from another model B7 at all repetition rates.

NOTE: Both rise and fall time may be degraded simultaneously to approximately one (1) microsecond.

OVERSHOOT & UNDERSHOOT 5%, maximum, except when pulse is attenuated more than 30db. with the 10db. step attenuator. 30%, maximum, at 50db. down.

DROOP:

0-100 μ sec. wide pulse	Negligible.
100-1,000 μ sec. wide pulse	15%, maximum.
1,000-10,000 μ sec. wide pulse	25%, maximum.

DUTY FACTOR 30%, maximum, at full amplitude.

ATTENUATION 0 to 60db., continuously variable.

OUTPUT IMPEDANCE 50 Ω .

MISCELLANEOUS SPECIFICATIONS

The following are miscellaneous specifications of the instrument.

POWER REQUIRED	115V., 3.2 amps., 50-60 cps, 325 watts.
VENTILATION	Forced air.
DIMENSIONS	8 3/4" X 19 1/2" X 12".
WEIGHT, NET	42 lbs.
WEIGHT, SHIPPING	56 lbs.
ACCESSORIES INCLUDED	One instruction manual.

OPERATING INSTRUCTIONS

FRONT PANEL CONTROLS

Refer to Fig. C for the location of all of the front panel controls described below.

FREQUENCY RANGE SWITCH When operated in the internal oscillator positions rotary switch S110 switches timing capacitors C110 through C115 in the grid to ground circuit of V11A to determine the frequency range of the oscillator. In the two external trigger positions, positive or negative, depending on the polarity of the input pulse, the switch selects the positive pulse from external trigger tube V10A and applies it to the grid of V11A.

FINE FREQUENCY AND TRIGGER SENSITIVITY CONTROL

Potentiometer R112 varies the voltage at the grid of V11A to determine the repetition rate of the oscillator on any of the frequency ranges. During periods of external trigger operation this potentiometer becomes the trigger

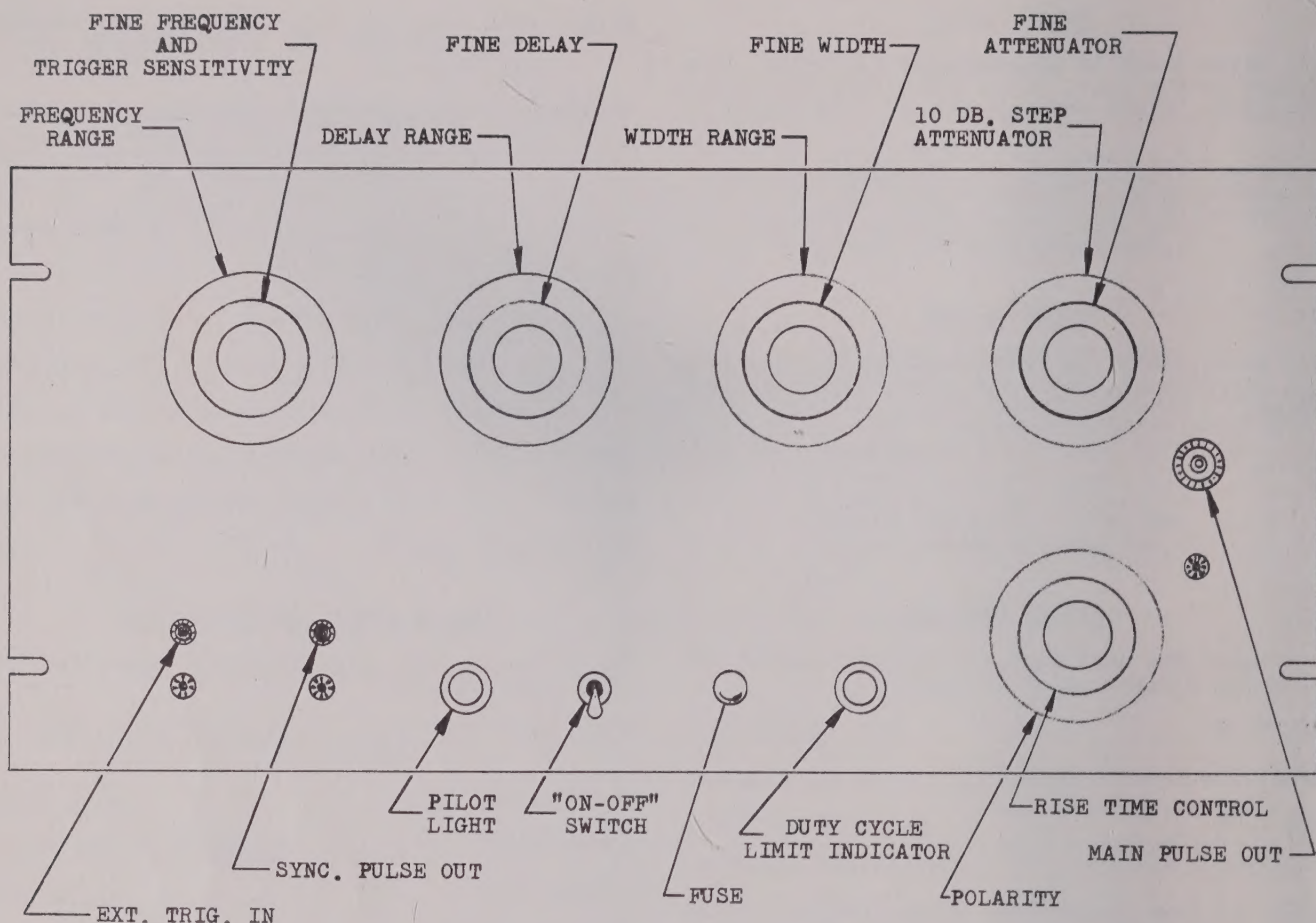


FIG. C FRONT PANEL CONTROLS

sensitivity control to determine the triggering level.

DELAY RANGE SWITCH Rotary switch S200 switches timing capacitors C200 through C205 in the grid to ground circuit of V20A to determine the range of pulse delay.

FINE DELAY CONTROL Potentiometer R200 varies the cathode to ground resistance of the pulse width multivibrator, affording continuous delay settings on all delay ranges.

WIDTH RANGE SWITCH Rotary switch S300 switches timing capacitors C300 through C305 in the grid to ground circuit of V30A to determine the range of pulse width.

FINE WIDTH CONTROL Potentiometer R300 varies the cathode to ground resistance of the pulse delay multivibrator, affording continuous width settings on all width ranges.

10db. STEP ATTENUATOR Rotary switch S800 con-

trols the amplitude of the output pulse in 10db steps.

FINE ATTENUATOR CONTROL Potentiometer R53 affords a continuously variable attenuation of approximately 20db.

POLARITY SWITCH Rotary switch S450 determines the polarity of the output pulse by grounding various levels of the floating power supply and applying its voltages to the output tubes.

RISE TIME CONTROL Potentiometer R401 varies the resistance in the output tube control grid circuits, affording simultaneous degradation of rise and fall times to approximately one microsecond.

EXTERNAL TRIGGER IN J100 couples an external trigger through C100 to the control grid of the external trigger amplifier, V10A.

SYNC. PULSE OUT J101 takes the synchronizing pulse from the cathode of the sync. pulse cath-

ode follower, V10B.

PILOT LIGHT Lamp LT500 lights when 115V. AC, 50-60 cps, single phase power is applied to the power transformer, T500.

ON-OFF SWITCH S500 applies power to the primary winding of the power transformer, T500.

FUSE 3 2/10 ampere "slo-blo" fuse F500 protects the pulse generator from overloads.

DUTY CYCLE LIMIT INDICATOR Lamp LT530 lights when the 30% duty factor limitation is exceeded. This lamp, when lit, is a warning to the operator that the amplitude of the output pulse is being automatically reduced.

MAIN PULSE OUT Coaxial connector J800 takes the main pulse from the output of the 10db. step attenuator.

PRELIMINARY INSTRUCTIONS

VENTILATION The model B7 pulse generator is cooled by forced air. It is imperative that both ends of the instrument be kept free of obstruction at all times in order to insure adequate air flow.

It is inadvisable to operate the instrument for appreciable lengths of time with the dust covers removed. These covers not only help to keep the instrument free from dust and other foreign matter, but also properly direct the flow of air through the instrument. Therefore, if the end covers are removed and the instrument mounted in a rack, the dust cover sections must be replaced before rack mounting.

DUTY FACTOR LIMITATION The dissipation limitations of the 6DQ5 power amplifier tubes limit the duty factor of the model B7 pulse generator to 30%, i.e., at full pulse amplitude, the pulse width must never equal greater than 30% of the pulse to pulse spacing. Operation up to approximately 70% duty factor is possible with reduced pulse amplitude.

The 30% duty factor limitation is automatically controlled in the model B7. Should the duty factor limitation be exceeded, the model B7 automatically reduces the amplitude of the output pulse to such a level that the ratings of the output tubes are not exceeded. When the duty cycle limiter is in operation, the duty cycle lamp on the front panel lights, warning the operator of the reduced pulse amplitude condition.

FIRST TIME OPERATION The following procedure is recommended for putting the instrument into operation for the first time.

1. Turn the power switch to "OFF" and connect the line cord to a source of 115 volts, 50-60 cps power.
2. Set the instrument controls as follows:

- a. Frequency Range ----- 200KC
- b. Frequency ----- 100KC

- c. Delay Range - 0 to 1 microsecond
- d. Delay ----- 0 microsecond
- e. Width Range - 1 to 10 microseconds
- f. Width ----- 1 microsecond
- g. 10db. Step Attenuator ----- 0db
- h. Fine Attenuator ----- 0db
- i. Polarity ----- "+"
- j. Rise Time ----- clockwise

3. Connect a synchroscope as follows:

- a. Sweep - 1 microsecond/centimeter
- b. Vertical Deflection - 20 volts per centimeter
- c. Trigger -- External from the sync. out connector on the model B7 front panel.

4. Connect a ground strap from one of the model B7 ground binding posts to a ground binding post on the synchroscope.

5. Connect a 50 Ω resistive load between the pulse out connector and ground. The output impedance of the model B7 is 50 Ω and it is imperative that it be properly terminated if the true output waveform is to be observed.

6. Connect the input probe of the synchroscope across the 50 Ω external load. If the true waveform of the output pulse is to be observed, it is imperative that the synchroscope input probe be properly compensated for viewing step function waveforms by adjusting the compensating capacitor in the probe itself and that the probe ground strap be connected to the instrument ground.

7. Turn the model B7 power switch to "ON" and allow approximately one (1) minute for the instrument to reach operating temperature. Adjust the trigger sensitivity of the synchroscope for a stable trace. The model B7 controls may now be set to any desired values within the 30% duty factor limitation.

MAINTENANCE

DANGER

The power supplies in this instrument operate at voltages which are dangerous to personnel. Extreme caution must be exercised at all times. Repair or maintenance work should never be attempted unless competent personnel, thoroughly trained in the accepted methods of artificial respiration, are in attendance.

DANGER

The following maintenance suggestions are designed to aid the maintenance technician in scheduling regular preventative as well as cor-

rective maintenance routines. It is important that maintenance routines be performed regularly to obtain maximum life and usefulness from the instrument.

FAN MOTOR The fan motor bearings require oil periodically. Use a good grade of light machine oil and apply only a drop or two every six months.

CLEANING THE INSTRUMENT At regular intervals, any dust that has settled on the interior of the instrument should be removed by means of dry compressed air. AVOID high velocity air streams which might injure the instrument or disturb adjustments. Persistent dirt may be removed with a lint-free cloth and, if necessary, carbon tetrachloride.

Under normal conditions, the silver plated contacts of the rotary switches should not require special attention. In case they become tarnished, the contacts should be cleaned by rotating the switch several times.

INSPECTION A visual inspection for loose or broken wiring, loose hardware, and discolored or deformed components is desirable while the instrument is being cleaned.

SWITCHES Turn the rotary switches while observing the contacts to check contact centering in each index position. Improperly centered contacts may be due to the switch becoming warped or twisted. AVOID pressure on the contacts as they are easily damaged.

CAPACITORS AND RESISTORS Inspect the electrolytic capacitors for leakage of electrolyte. Replace if necessary. The wax coating of the paper tubular capacitors may drip if the instrument has been overheated by operation in a restricted space. This condition usually does not indicate replacement.

Composition resistors should be checked for serious discoloration which would indicate excessive dissipation and, therefore, faulty operation. A moderate amount of discoloration is normal.

RACK MOUNTING The model B7, as purchased, is a portable instrument. It may, however, be mounted in a rack with other instrumentation by removing the louvered end panels. To remove the end panels, first remove both sections of the dust cover. The six sheet metal screws which hold each louvered end panel to the inner end panels are now accessible. Remove these screws and the two screws which hold each end panel to the front panel. Replace both dust covers on the instrument and it is ready for rack mounting. The dust covers must be put back on the instrument before rack mounting as they not only serve to keep dust and other foreign matter out of the instrument, but also help to properly direct the flow of cooling air through the instrument.

CALIBRATION The model B7 contains several controls for the purposes of calibration, pulse shape adjustment, etc. These controls are pre-

set at the factory and should not require readjustment except due to component aging or when electron tubes are replaced.

When readjustment of these controls becomes necessary, the instrument should be allowed to operate for one hour prior to adjustment in order that all components may reach their normal operating temperatures and the instrument has reached maximum stability.

The following controls are on the chassis. Refer to the component location diagram (B7-D-102) inside the bottom dust cover for their location.

R110 - Calibrates the low end of the frequency ranges.

R113 - Calibrates the high end of the frequency ranges.

NOTE: There is some interaction between R110 and R113. Therefore, each control should be readjusted several times until the calibration at both ends of the range is correct.

R206 - Calibrates the delay ranges.

R306 - Calibrates the width ranges.

C400 - Overshoot control.

R354 - Droop control.

C353 and C370 - Pulse shape controls, leading edge.

NOTE: R354, C353, C400, and C370 should be adjusted for optimum pulse shape as seen on a synchroscope.

R473 - Grid restoration control. This control is set for minimum voltage across R800 at full output pulse amplitude.

R513 - Adjusts the +150 volts, regulated.

R603 - Duty cycle limit adjust. This control must never be set for a full amplitude pulse at greater than 30% duty factor or the life of the output tubes will be seriously shortened.

The following controls are mounted on the rotary switches immediately behind the front panel.

C115 - Fine frequency calibrate on the two (2) megacycles/second range.

C205 - Fine delay calibrate on the one (1) microsecond range.

C305 - Fine width calibrate on the one (1) microsecond range.

TROUBLE SHOOTING It is of extreme importance that the operation, theory, and physical location of components be thoroughly understood before any repair of the instrument is undertaken. A careful study of the circuit descriptions and the schematic diagram will in most instances, indicate the cause for a particular difficulty in a much shorter time than will a blind point to point check of the entire instrument. It is also suggested that whenever an operational difficulty is encountered, a recheck of the settings

and adjustment of the operational controls will often times reveal that a control has been inadvertently set in the wrong position and that this is the cause of the difficulty.

ELECTRON TUBE FAILURE A major cause of equipment failure is weak or inoperative electron tubes. When a system failure has been traced to a particular circuit, it will be found expedient to test the electron tubes in that circuit, replacing all weak or inoperative ones, before a more detailed examination of the circuit is undertaken. A HICKOCK #539A Tube Checker has been found very satisfactory in detecting electron tubes with low transconductance.

ISOLATION OF THE DEFECTIVE CIRCUIT The following trouble shooting procedure is designed to isolate the trouble to one particular circuit.

Complete failure of the instrument to operate indicates a power source difficulty. Check the source of power and make certain that the power cord plug is firmly in place. Check the fuse on the instrument front panel. A blown fuse indicates an overload condition within the instrument. Blown fuses should not be indiscriminately replaced without first ascertaining the cause of overload, as further damage is likely to result.

If power is applied to the instrument but it still fails to operate, a check should be made of the power supply voltages. For this and subsequent checks, it will be necessary to remove the dust covers from the instrument.

It will be necessary to use a synchroscope for further checks. It is important that a synchroscope with a wide band-pass be used as it is impossible to observe many of the fast rise times and narrow pulse widths on an inferior synchroscope. The Tektronix models 517, 541, 543, or 545 have been found satisfactory in observing the waveforms present in the instrument.

The waveforms shown on the schematic diagram (B7-100) were made from a representative, production run instrument and should prove invaluable as a comparison for waveforms found in any one instrument. Any particular instrument, however, may display slight variations in waveform due to component tolerance, etc. The maintenance technician is advised to observe the waveforms in his particular instrument at a time when it is in good operating condition, noting any variations from the waveform photographs on his schematic diagram for reference at a time when the instrument becomes inoperative.

If the instrument has no output pulse, check for a sync. pulse at the sync. out jack on the instrument front panel. If there is no sync. pulse, the trouble is in the oscillator section of the instrument. If, however, a sync. pulse is present, synchronize a synchroscope with this pulse and proceed as follows.

Check for a pulse at the input of the attenuator switch, S800. A pulse here isolates the trouble to the switch or its components. If no pulse or a deformed pulse is present, check

for a pulse at pins 3 and 6 of V40. If a normal pulse is present at this point, the faulty circuitry is in the output section.

If no pulse is present at the cathodes of V40, the trouble will probably be found in the width multivibrator or blocking oscillator. If, however, a deformed pulse is present, a study of its shape will be helpful in quickly finding its cause.

If the deformed pulse shows a very slow rise time and normal fall time, the start pulse is missing. Check the start pulse channel. If there are very narrow pulses where the leading and trailing edges of the output pulse would normally be, the clamp circuit is inoperative. If the pulse rises normally and then immediately starts to decay slowly toward zero, the trouble lies in the clamp circuit or the width multivibrator circuit. Finally, if the pulse is normal except for a slow fall time, check the stop pulse channel for faulty operation.

In checking each subsection, it is advisable to start by looking for an output pulse from the section and then working back toward the start of the section. Thus, whenever a normal pulse is found, the trouble is isolated to the stage which immediately follows it.

CIRCUIT DESCRIPTION

OSCILLATOR SECTION The oscillator section consists of the external trigger amplifier, V10A; the free-running multivibrator, V11; the repetition rate blocking oscillator, V12; and the sync. pulse cathode follower, V10B. V10, V11, and V12 are type 6BQ7 dual triode electron tubes.

The repetition rate of the free-running multivibrator is determined by the action of two front panel controls. The range of the oscillator is determined by the selection of timing capacitors C110 through C115, in the grid circuit of V10A, by the oscillator range switch, S110. Fine repetition rate control of the multivibrator, through any range, is determined by varying the fine frequency potentiometer, R112, which varies the voltage to this grid circuit.

The limits of repetition rate for each range are set with the two calibration potentiometers, R110 and R113, which establish the range through which this voltage may vary.

The output, taken from the second plate of the multivibrator is used to trigger the repetition rate blocking oscillator. The basic repetition rate timing pulse is taken from the cathode of this blocking oscillator and is used to trigger the delay multivibrator.

The external trigger amplifier provides a means of triggering the instrument from an external source. The frequency range switch; in either the "EXT. TRIG. (+)" or the "EXT. TRIG. (-)" position, depending on the polarity of the

trigger into the external trigger amplifier, V10A; couples the positive pulse from V10A to the input grid of the multivibrator. Now, the multivibrator acts as a trigger shaper, giving a timing pulse from the oscillator section for each pulse in. Potentiometer R112 now becomes a trigger sensitivity control to set the triggering level.

The timing pulse taken from the cathode of the repetition rate blocking oscillator is also coupled through a 0.2 microsecond delay line to the grid of the sync. pulse cathode follower. The pulse taken from the cathode is brought to the instrument front panel to be used as a synchronizing pulse for use with other instrumentation. Due to the fact that the sync. pulse occurs approximately 0.2 microseconds after the pulse which triggers the pulse delay circuit, we are able to overcome the inherent delay of the remaining circuitry and can thus produce output pulses which are not delayed in time with respect to the sync. pulse.

DELAY SECTION The delay section consists of the delay multivibrator, V20, and the delay blocking oscillator, V21. V20 and V21 are type 6BQ7 dual triode electron tubes.

The monostable multivibrator, V20, is triggered from its stable state to its quasi-stable state by positive pulses from the oscillator section which are coupled into the grid of V20B and the plate of V20A through diode X200. The length of time which the multivibrator remains in this quasi-stable state, determined by the timing capacitor in the grid circuit of V20A and the cathode to ground resistance of V20, is the delay time of the circuit. Thus, this circuit determines the time between the oscillator section timing pulse and the start of the main pulse.

The range of delay is determined by the selection of timing capacitors C200 through C205 by the delay range switch, S200. Fine delay control throughout any range is determined by varying the cathode to ground resistance with the fine delay potentiometer, R200.

R206 sets the voltage to which the grid circuit is returned, thus providing calibration for the various ranges.

A pulse, created by the return of the multivibrator to its stable state after this predetermined delay, is coupled from the plate of V20B to trigger the delay blocking oscillator, V21.

The pulse taken from the cathode of the blocking oscillator is known as the "start pulse". This start pulse goes to the amplifiers in the start channel and to the width section where it is used to trigger the width multivibrator.

WIDTH SECTION The pulse width section consists of the width multivibrator, V30. V30 is a type 6BQ7 dual triode electron tube.

The monostable multivibrator, V30, is trig-

gered from its stable state to its quasi-stable state by positive pulses from the delay section which are coupled into the grid of V30B and the plate of V30A through diode X300. The length of time which the multivibrator remains in this quasi-stable state, determined by the timing capacitor in the grid circuit of V30A and the cathode to ground resistance of V30, is the delay time of this circuit. Thus, this circuit determines the time between the delay section output pulse which starts the main pulse and the width section output pulse which stops the main pulse.

The range of pulse width, is determined by the selection of timing capacitors C300 through C305 by the width range switch, S300. Fine width control throughout any range is determined by varying the cathode to ground resistance with the fine width potentiometer, R300.

R306 sets the voltage to which the grid circuit is returned, thus providing calibration for the various ranges.

Two outputs are taken from the width multivibrator. The first is the waveform taken from the plate circuit of V30B. This waveform is a negative going pulse equal in time duration to the delay time of the width multivibrator. It is coupled through C351 to the grid of the clamp tube, V35B. The second output, a pulse created by the return of the multivibrator to its stable state after the predetermined delay, is known as the "stop pulse". This stop pulse is coupled into the amplifiers in the stop channel.

START PULSE CHANNEL The start pulse channel consists of three pulse shaping amplifier stages and the leading edge forming tube. V25 and V26 are type 5687 dual triode electron tubes. V27 is a type 6BQ7 dual triode electron tube.

The start channel receives the positive start pulse from the delay section through a 0.02 microsecond delay line, DL250. This delay line delays the start pulse without delaying the stop pulse, thus allowing a minimum output pulse width of 0.05 microseconds. This pulse goes through three pulse transformer coupled amplifier stages; V25A, V25B, and V26. Pulse transformer T260 couples the amplified pulse into the grids of the leading edge forming tube, V27. This tube drives the output pulse cathode follower, in the pulse forming section, to form the leading edge of the output pulse.

STOP PULSE CHANNEL The stop pulse channel consists of three pulse shaping amplifier stages and the trailing edge forming tube. V35A is of a type 6BQ7 dual triode electron tube. V36 and V37 are type 5687 dual triode electron tubes.

The stop channel receives the positive stop pulse from the width section. It is sent through three stages of transformer coupled amplification; V35A, V36A, and V36B, into the grids of the trailing edge forming tube, V37. This tube drives the output pulse cathode follower, in the pulse forming section, to form the trailing edge of the output pulse.

OUTPUT SECTION The output section consists of the clamp tube, V35B; the pulse forming cathode follower, V40; two power amplifier tubes, V45 and V46; the control grid restoration diode, V47A; and the screen grid disconnect diode, V47B. Electron tubes V35B and V47 are 1½ type 6BQ7 dual triodes, V40 is a type 5687 dual triode, and V45 and V46 are type 6DQ5 power pentodes.

The clamp tube receives its input from the plate circuit of V30B in the pulse width section. During the period between output pulses, it conducts fully, holding the output at the zero level. Between the start and stop pulses it is completely cut off by the signal from the width multivibrator and holds the output pulse at full amplitude.

The grids of the pulse forming cathode follower are driven positive by the leading edge forming tube, held there by the clamp tube, and driven back to their original level by the trailing edge forming tube. From the cathodes of this tube, we take the fully shaped output pulse. This pulse is coupled through the rise time control circuitry to the control grids of the power amplifiers.

The power amplifiers, connected in parallel, act as a cathode follower for a positive pulse out, and as an inverting amplifier for a negative pulse out. This is accomplished by the action of the polarity switch, S450, which switches the floating power supply voltages to the output power amplifiers as well as coupling the output pulse to the attenuator.

Triode V47A, connected as a diode, provides restoration at the control grids of the output tubes. The restoration level is adjusted by potentiometer R473. V47B, as connected, acts as the screen grid disconnect diode for the output amplifiers.

Finally, the output pulse is sent to the step attenuator, consisting of five 10db. constant impedance T-sections, and to the pulse output jack on the instrument front panel.

POWER SUPPLY SECTION The power supply section contains the power transformer, T500; V50, a type 0A2 voltage regulator tube; V51, a type 6080 dual triode electron tube; V52, a type 6U8 triode-pentode electron tube, and their associated circuitry which includes two controls for varying the amplitude of the output pulse.

The power supply section furnishes five unregulated DC voltages (+250V., -4V., -8V., -18V., and -24V.), and three regulated voltages (+150V., -150V., and a positive variable voltage) from its ground reference supplies. From its floating supply it furnishes 150V. above and below a zero reference. It also furnishes filament power for all of the electron tubes in the unit.

The +150V. supply is regulated by the action of V51A and V52A. It may be adjusted by potentiometer R513 in the grid circuit of V52A.

The -150V. supply is regulated by the action of the voltage regulator tube, V50. This supply is not adjustable.

The positive variable voltage, used in two places; as plate supply for the last stage of start pulse amplification and as plate supply for the clamp tube; furnishes a means of varying the amplitude of the output pulse. This supply is regulated by the action of V51B and V52B. Its reference, however, is set by V53B.

This reference may be varied in two ways. First, it may be varied by varying the fine attenuation potentiometer, R532. Secondly, it may be varied by the action of the duty cycle limiting control consisting of the circuitry of T600 and V53A.

Transformer T600 senses the ripple voltage in the zero leg of the floating supply. This ripple voltage increases as the output power amplifiers draw more current. The bias on the control grid of V53A is set at such a level by potentiometer R603 that the ripple voltage will take control of the tube at the point where the power amplifiers are drawing rated current and change the reference to lower the variable supply voltage. Thus, the output tubes are never allowed to exceed their dissipation ratings even if the duty factor limitation is inadvertently exceeded. At the time the variable voltage starts to decrease due to duty cycle limiting, the front panel lamp, LT530, lights to warn the operator that the amplitude of the output pulse is being automatically reduced.

CIRCUIT THEORY

This section of the manual contains explanations of several basic circuits which are used in the model B7. Inasmuch as the technician may not be totally familiar with high repetition rate pulse handling circuitry, it is felt that the inclusion of this section in the manual will lend to a more thorough understanding of the instrument.

FREE-RUNNING MULTIVIBRATOR Fig. D is a simplified circuit of a free-running multivibrator similar to that used in the oscillator section of the model B7.

The multivibrator does not have a stable state. That is, neither tube section is capable of remaining in conduction indefinitely. Therefore, in operation, the circuit continually changes from the condition of one triode section conducting and the other non-conducting, to the opposite condition, and back again.

Arbitrarily assume that at any specified instant, triode section V2 is conducting fully and triode section V1 is non-conducting because the potential at its control grid is below the cut-off potential of the tube. At this instant, the cathodes of both sections are positive and the plate of V2 is at its lowest potential due

to the current through R3, V2, and R8. Capacitor C1, however, is charging exponentially toward the positive voltage, Bv+, through resistor R1.

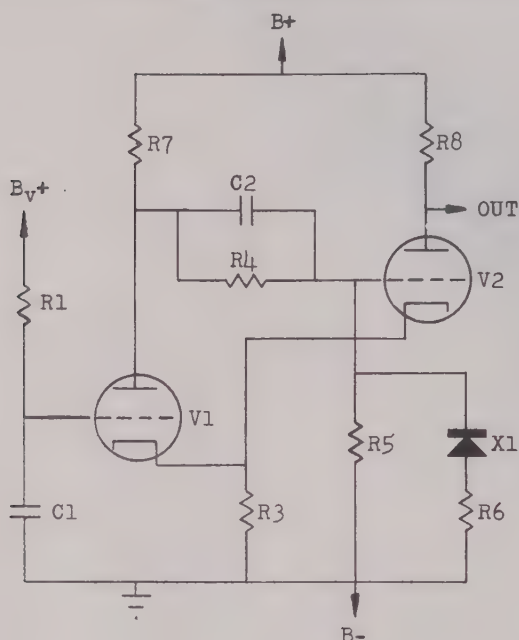


FIG. E- FREE-RUNNING MULTIVIBRATOR

After a time, determined by the charging time of C1 through R1, the potential at the control grid of V1 reaches the cut-in potential of the tube. V1 starts to conduct and its plate potential drops. This drop is immediately felt at the grid of V2, across C2, driving it below cut-off. Its plate potential rises sharply and the cathodes drop sharply, further aiding the conduction of V1. After the initial drop is felt across C2, the grid of V2 starts to return exponentially to the positive level established by the R4, R5, and R7 dividing network and at the same time C1 discharges quickly through the low grid to cathode resistance of the conducting V1.

Thus, in a short period of time, V1 has started conducting, V2 has been sharply cut off, C1 has quickly lost its charge to return the grid of V1 nearly to its cathode potential, and the grid of V2 is returning toward its cut-in level.

At the cut-in level of V2, it once again conducts fully. Its plate drops back to its previous level and the cycle starts over again.

By choosing component values such that the period of V2 in its non-conducting state is very short regardless of the length of time it is conducting, we are able to produce a train of sharp, narrow width timing pulses.

The circuit consisting of X1 and R6 insures that the grid of V2 can never be driven excessively negative, thus insuring a fast recovery time from non-conduction to conduction of V2.

The repetition rate of the circuit is determined by the time constant of the R1 and C1 combination and the voltage to which it is returned. The maximum repetition rate of the circuit is limited only by the recovery time of V2 from non-conduction to conduction.

In the model B7 the range of the repetition rate of the oscillator multivibrator is changed by changing the value of C1 in decade steps and its repetition rate is made continuously variable through any range by varying the return voltage. The 2 megacycle maximum repetition rate is made possible by the extremely fast recovery time of the circuit. The sharp positive pulses, taken from the second plate, are shaped and amplified to become the timing pulses of the model B7.

MONOSTABLE MULTIVIBRATOR Fig. E shows a simplified circuit of a monostable multivibrator similar to those used in the pulse delay and pulse width sections of the model B7.

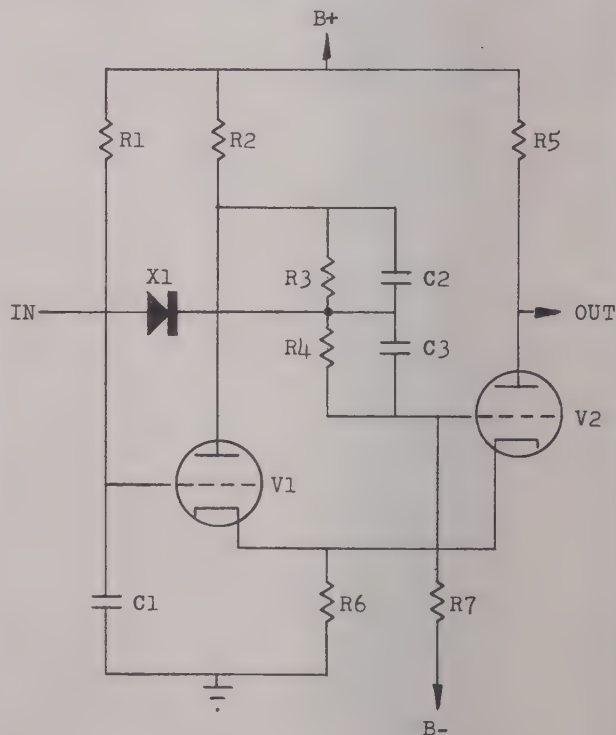


FIG. D MONOSTABLE MULTIVIBRATOR

The multivibrator has one stable state and one quasi-stable state. That is, one tube sec-

tion is capable of remaining in the conducting state indefinitely while the other does not have this capability. In this type of multivibrator it is necessary to trigger the circuit from its stable state to its quasi-stable state with trigger pulses from an external source. Then, the circuit will automatically return to its stable state after a certain length of time. Therefore, in operation, one triode section is triggered from non-conduction to conduction with an applied trigger. It remains in this condition for a predetermined length of time and then returns abruptly to the non-conducting state to await another trigger. Thus, we are able to generate a pulse, at a predetermined time after a given input pulse, by abruptly changing a tube section from conduction to non-conduction. Or, essentially, we have introduced a delay into the system.

Assume that the circuit is in its stable state. V1 is conducting, its grid clamped to its cathode. If R2 is made quite large, the full conduction current through V1 and thus through R6 is small and the grid is clamped near zero potential. The plate of V1, however, is at quite a low potential due to the current through the large R2. V2 is not conducting, its grid held below cut-off by the divider formed by R3, R4, and R7 between the low positive plate potential of V1 and -150 volts.

Now, at some time, a positive timing pulse arrives at the junction of the C2-R3, C3-R4 combination through diode X1. This pulse is felt sharply across C2 and C3 at the plate of V1 and the grid of V2. V1 starts to cut off. V2 starts conducting. If R5 is small compared to R2, V2 will conduct much more heavily than V1 was conducting. The drop across R6 becomes greater due to this higher current through V2, thus the cathodes raise to a higher potential. This holds V1 off completely. The plate of V1, now at a higher potential, keeps the grid of V2 above its cut-off potential by the same divider network mentioned above. Thus, in a very short time, a trigger pulse has changed the state of the multivibrator from that of V1 conducting a small amount and V2 cut off, to one of V1 cut off and V2 conducting quite heavily.

As soon as V1 is cut off by raising its cathode potential several volts with respect to its grid potential, C1 starts to charge through R1 toward the B+ potential. After a time, predetermined by the R1-C1 combination, the grid of V1 will reach cut-in potential and V1 will again start to conduct. The plate of V1 drops. This drop is felt at the grid of V2 through C2 and C3, immediately cutting off V2. The drop which cuts V2 off also drops the cathode potentials, which aids the conduction of V1. C1 discharges rapidly through the low grid to cathode resistance of V1, and the circuit has returned to its original stable state. At the transition point of V2 conducting to non-conducting, the plate wave form of V2 goes sharply positive. This waveform is taken as the output. Thus, we have produced a pulse, delayed from the original trigger pulse, by a time predetermined by R1-C1.

In the model B7 the range of delay of the

pulse delay and pulse width multivibrators is changed by changing the value of C1 in decade steps. Delay and width are made continuously variable through any range by varying R6, which varies the cathode potential in the quasi-stable state, thus determining the potential which the grid must reach to cut V1 on and return the multivibrator to its stable state.

BLOCKING OSCILLATOR Fig. F shows a typical blocking oscillator circuit such as is used in the model B7 oscillator and pulse delay sections.

This blocking oscillator is a so-called monostable or driven type. That is, it is not free-running, but requires a trigger from an external source to excite it. It produces a high powered, extremely sharp, narrow pulse which is essentially independent of the shape or degradation of the pulse which triggers it.

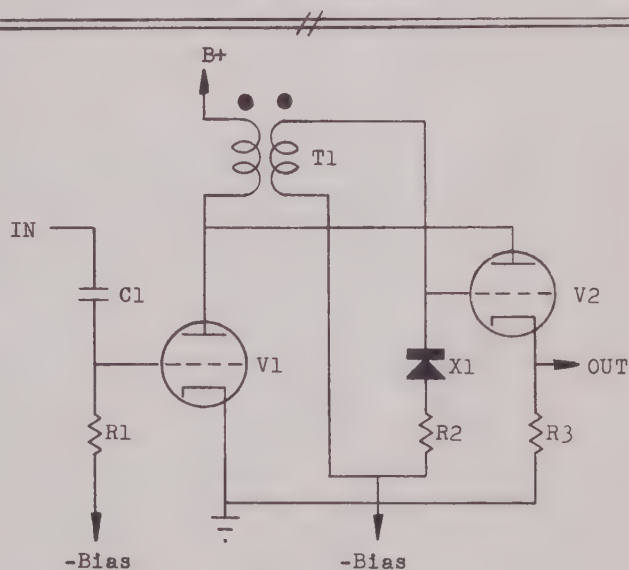


FIG. F MONOSTABLE BLOCKING OSCILLATOR

V1 serves to amplify the input trigger and to eliminate the possibility of a reaction by the blocking oscillator back on the trigger pulse source.

In the quiescent condition, both sections of the tube are biased below cut-off. A positive trigger is coupled through C1 to the amplifier tube, V1, which inverts and amplifies it. Pulse transformer T1 inverts and applies this waveform to the grid of V2, the blocking oscillator tube. V2 conducts causing a drop in its plate voltage. The drop in plate voltage in turn causes an increase in grid voltage, which results in a further decrease in plate voltage. Due to the a.c. loop gain of the circuit being greater than unity, regeneration occurs. The plate drives abruptly downward and the grid drives abruptly upward. This action continues

until such time as the loop gain drops below unity, due to the non-linearity of the tube.

The plate and grid cannot remain at the values attained by the regenerative action described above because of the low frequency characteristics of the transformer. The grid starts drop due to its finite magnetizing inductance. When the grid voltage has dropped far enough that the loop gain once more equals unity, a regenerative action once again occurs in the direction to turn the tube off.

An overshoot occurs at the plate and grid of the tube. At the conclusion of the pulse there is still a current flowing in the magnetizing inductance of the transformer. Since this

current cannot change instantaneously, it continues to flow through the effective capacitance of the transformer after the tube current has dropped to zero, causing this overshoot.

The pulse width and rise time are dependent almost entirely on the design of the transformer. The pulse transformers used in the model B7 blocking oscillators are specially designed to produce extremely narrow, fast rise time pulses.

In the oscillator and pulse width sections of the model B7, blocking oscillators such as described above are used. In both of these cases, a positive pulse is taken from the cathode as the output pulse.

PARTS LIST

NOTE: Capacitors marked with an asterisk (*) are bridged and grouped to $\pm 1\%$ accuracy at our factory. If it becomes necessary to replace any one of these capacitors, all of the capacitors on the switch should be replaced with a set obtained through our sales department.

ABBREVIATIONS

cer	ceramic	k	kilohm of 10^3 ohms	prec	precision
comp	composition	m	milli or 10^{-3}	PT	paper tubular
EMC	electrolytic, metal cased	meg	megohm or 10^6 ohms	SM	silvered mica
EMT	electrolytic, metal tubular	MF	metal film	V	working volts, DC
f	farad	μ	micro or 10^{-6}	var	variable
GMV	guaranteed minimum value	$\mu\mu$	micromicro or 10^{-12}	W	watt
h	henry	Ω	ohm	WW	wire wound

CAPACITORS

C100	.01 μ f	fixed	cer	500V	GMV				
C101	5 μ f	fixed	SM	500V	$\pm 5\%$				
C102	5 μ f	fixed	SM	500V	$\pm 5\%$				
C103	2 μ f	fixed	EMT	450V	-10+50%				
C104	.01 μ f	fixed	cer	500V	GMV				
C110*	.47 μ f	fixed	mylar	150V	$\pm 5\%$				
C111*	.047 μ f	fixed	mylar	150V	$\pm 5\%$				
C112*	.0047 μ f	fixed	SM	500V	$\pm 5\%$				
C113*	470 μ f	fixed	SM	500V	$\pm 5\%$				
C114	22 μ f	fixed	SM	500V	$\pm 5\%$				
C115	4-30 μ f	var	cer	500V					
C116	22 μ f	fixed	SM	500V	$\pm 5\%$				
C117	.01 μ f	fixed	cer	500V	GMV				
C121	100 μ f	fixed	cer	500V	$\pm 10\%$				
C122	100 μ f	fixed	cer	500V	$\pm 10\%$				
C200*	.47 μ f	fixed	mylar	150V	$\pm 5\%$				
C201*	.047 μ f	fixed	mylar	150V	$\pm 5\%$				
C202*	.0047 μ f	fixed	SM	500V	$\pm 5\%$				
C203*	470 μ f	fixed	SM	500V	$\pm 5\%$				
C204	22 μ f	fixed	SM	500V	$\pm 5\%$				
C205	4-30 μ f	var	cer	500V					
C206	39 μ f	fixed	SM	500V	$\pm 5\%$				
C207	39 μ f	fixed	SM	500V	$\pm 5\%$				
C208	2 μ f	fixed	EMT	450V	-10+50%				
C210	100 μ f	fixed	cer	500V	$\pm 10\%$				
C250	100 μ f	fixed	cer	500V	$\pm 10\%$				
C260	1.5-7 μ f	var	cer	500V					
C261	.01 μ f	fixed	cer	500V	GMV				
C262	.01 μ f	fixed	cer	500V	GMV				
C270	.01 μ f	fixed	cer	500V	GMV				
C300*	.47 μ f	fixed	mylar	150V	$\pm 5\%$				
C301*	.047 μ f	fixed	mylar	150V	$\pm 5\%$				

C302*	.0047 μ f	fixed	SM	500V	$\pm 5\%$	CHOKES					
C303*	.470 μ f	fixed	SM	500V	$\pm 5\%$	L110	25 μ h	fixed	$\pm 10\%$		
C304	.22 μ f	fixed	SM	500V	$\pm 5\%$						
C305	4-30 μ f	var	cer	500V							
C306	.39 μ f	fixed	SM	500V	$\pm 5\%$	L200	25 μ h	fixed	$\pm 10\%$		
C307	.39 μ f	fixed	SM	500V	$\pm 5\%$						
C308	2 μ f	fixed	EMT	450V	-10+50%						
C309	.01 μ f	fixed	cer	500V	GMV	L300	25 μ h	fixed	$\pm 10\%$		
C350	100 μ f	fixed	cer	500V	$\pm 10\%$						
C351	.25 μ f	fixed	MP	200V	$\pm 20\%$						
C352	.01 μ f	fixed	cer	500V	GMV	L450	.12 μ h	fixed	$\pm 15\%$		
C353	4-30 μ f	var	cer	500V		L451	.24 μ h	fixed	$\pm 15\%$		
C354	.01 μ f	fixed	cer	500V	GMV	L460 L461	.12 μ h .24 μ h	fixed fixed	$\pm 15\%$ $\pm 15\%$		
C360	.01 μ f	fixed	cer	500V	GMV						
C370	4-30 μ f	var	cer	500V							
C371	.01 μ f	fixed	cer	500V	GMV	CONNECTORS					
C400	.01 μ f	fixed	cer	500V	GMV	J100	Nylon Binding Post				
C401	.5 μ f	fixed	MP	600V	$\pm 20\%$	J101	Nylon Binding Post				
C450	20 μ f	fixed	EMT	250V	-10+50%	J800		Type	SO-239		
C451	.01 μ f	fixed	cer	500V	GMV						
C460	.01 μ f	fixed	cer	500V	GMV						
C461	20 μ f	fixed	EMT	250V	-10+50%	DELAY LINES					
C470	.25 μ f	fixed	MP	200V	$\pm 20\%$	DL100	.2 μ second	fixed			
C500	80-80 μ f	fixed	EMC	350V	-10+50%	DL250	.02 μ second	fixed			
C501	80-80 μ f	fixed	EMC	350V	-10+50%						
C502	80-80 μ f	fixed	EMC	350V	-10+50%						
C503	.1 μ f	fixed	PT	400V	$\pm 20\%$	DIODES					
C510	.1 μ f	fixed	PT	400V	$\pm 20\%$	X110	Type 1N116				
C511	2 μ f	fixed	EMT	450V	-10+50%	X120	Type 1N116				
C520	.1 μ f	fixed	PT	400V	$\pm 20\%$	X200 X201	(Hughes Aircraft Co. ONLY)	Type 1N116 Type 1N116			
C521	2 μ f	fixed	EMT	450V	-10+50%						
C530	.1 μ f	fixed	PT	400V	$\pm 20\%$						
C531	.1 μ f	fixed	PT	400V	$\pm 20\%$	X210	Type 1N116				
C600	200-200 μ f	fixed	EMC	250V	-10+50%	X250		Type	1N98		
C601	200-200 μ f	fixed	EMC	250V	-10+50%						
C602	200-200 μ f	fixed	EMC	250V	-10+50%						
C603	200-200 μ f	fixed	EMC	250V	-10+50%	X260		Type	1N98		
C604	50 μ f	fixed	EMT	50V	-10+100%						
C700	1500 μ f	fixed	EMC	50V	-10+100%	X300 X301	(Hughes Aircraft Co. ONLY)		Type 1N116 Type 1N116		
C800	.25 μ f	fixed	MP	200V	$\pm 20\%$	X360 X361		Type 1N98 Type 1N98			
C801	.01 μ f	fixed	cer	500V	GMV						
C802	.01 μ f	fixed	cer	500V	GMV						
						X370	Type 1N98				

X500	Rectifier, Silicon	200ma	360 PIV
X501	Rectifier, Silicon	200ma	360 PIV
X502	Rectifier, Silicon	200ma	360 PIV
X503	Rectifier, Silicon	200ma	360 PIV
X504	Rectifier, Silicon	200ma	360 PIV
X505	Rectifier, Silicon	200ma	360 PIV

LAMPS

LT500

#47

LT530

NE51

X530	Rectifier, Silicon	200ma	360 PIV
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X600	Rectifier, Silicon	500ma	400 PIV
X601	Rectifier, Silicon	500ma	400 PIV
X602	Rectifier, Silicon	200ma	360 PIV
X603	Rectifier, Silicon	200ma	360 PIV
X604	Rectifier, Silicon	200ma	360 PIV

RESISTORS

X700	Rectifier, Silicon	200ma	360 PIV
X701	Rectifier, Silicon	200ma	360 PIV

ELECTRON TUBES

V10	Type	6BQ7
V11	Type	6BQ7
V12	Type	6BQ7

V20	Type	6BQ7
V21	Type	6BQ7

V25	Type	5687
V26	Type	5687
V27	Type	6BQ7

V30	Type	6BQ7
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V35	Type	6BQ7
V36	Type	5687
V37	Type	5687

V40	Type	5687
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V45	Type	6DQ5
V46	Type	6DQ5
V47	Type	6BQ7

V50	Type	0A2
V51	Type	6080
V52	Type	12AX7
V53	Type	6U8

FUSE

F500	3 2/10 ampere	Slo-blo
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R100	47Ω	fixed	comp	$\frac{1}{2}W$	±10%
R101	150k	fixed	comp	$\frac{1}{2}W$	±10%
R102	1k	fixed	comp	$\frac{1}{2}W$	±10%
R103	10k	fixed	comp	$\frac{1}{2}W$	±10%
R104	1k	fixed	comp	$\frac{1}{2}W$	±10%
R105	100k	fixed	comp	$\frac{1}{2}W$	±10%
R106	100k	fixed	comp	$\frac{1}{2}W$	±10%
R107	1.5k	fixed	comp	$\frac{1}{2}W$	±10%
R108	1k	fixed	comp	$\frac{1}{2}W$	±10%
R109	470Ω	fixed	comp	$\frac{1}{2}W$	±10%
R110	5k	var	comp	2W	±20%
R111	2.2k	fixed	comp	1W	±10%
R112	50k	var	comp	2W	±20%
R113	5k	var	comp	2W	±20%
R114	47k	fixed	comp	1W	±10%
R115	470Ω	fixed	comp	2W	±10%
R116	220Ω	fixed	MF	2W	± 5%
R117	470k	fixed	prec	$\frac{1}{2}W$	± 1%
R118	150k	fixed	comp	$\frac{1}{2}W$	±10%
R119	18k	fixed	comp	$\frac{1}{2}W$	±10%
R121	1k	fixed	comp	$\frac{1}{2}W$	±10%
R122	470Ω	fixed	comp	$\frac{1}{2}W$	±10%
R123	1k	fixed	comp	1W	±10%
R124	1k	fixed	comp	$\frac{1}{2}W$	±10%
R200	500Ω	var	comp	2W	±20%
R201	330k	fixed	comp	$\frac{1}{2}W$	±10%
R202	12k	fixed	comp	$\frac{1}{2}W$	±10%
R203	27k	fixed	comp	$\frac{1}{2}W$	±10%
R204	470Ω	fixed	comp	2W	±10%
R205	330k	fixed	prec	1W	± 1%
R206	100k	var	comp	2W	±20%
R207	100k	fixed	comp	$\frac{1}{2}W$	±10%
R208	47Ω	fixed	comp	$\frac{1}{2}W$	±10%
R209	470Ω	fixed	comp	$\frac{1}{2}W$	±10%
R210	3.3k	fixed	comp	$\frac{1}{2}W$	±10%
R211	470Ω	fixed	comp	$\frac{1}{2}W$	±10%
R212	470Ω	fixed	comp	2W	±10%
R250	1k	fixed	comp	$\frac{1}{2}W$	±10%
R251	150Ω	fixed	comp	$\frac{1}{2}W$	±10%
R260	330Ω	fixed	comp	$\frac{1}{2}W$	±10%
R261	1k	fixed	comp	2W	±10%
R262	1k	fixed	comp	2W	±10%
R300	500Ω	var	comp	2W	±20%
R301	330k	fixed	comp	$\frac{1}{2}W$	±10%
R302	12k	fixed	comp	$\frac{1}{2}W$	±10%
R303	27k	fixed	comp	$\frac{1}{2}W$	±10%
R304	470Ω	fixed	comp	2W	±10%

R305	330k	fixed	prec	$\frac{1}{2}W$	$\pm 1\%$	R537	6.8k	fixed	comp	2W	$\pm 10\%$
R306	100k	var	comp	2W	$\pm 20\%$	R538	6.8k	fixed	comp	2W	$\pm 10\%$
R307	100k	fixed	comp	$\frac{1}{2}W$	$\pm 10\%$						
R308	47 Ω	fixed	comp	$\frac{1}{2}W$	$\pm 10\%$						
R309	470 Ω	fixed	comp	$\frac{1}{2}W$	$\pm 10\%$	R600	.75 Ω	fixed	WW	4W	$\pm 5\%$
						R602	3.3meg	fixed	comp	$\frac{1}{2}W$	$\pm 10\%$
R350	3.3k	fixed	comp	$\frac{1}{2}W$	$\pm 10\%$	R603	50k	var	comp	2W	$\pm 20\%$
R351	3.3meg	fixed	comp	$\frac{1}{2}W$	$\pm 10\%$	R604	15k	fixed	comp	$\frac{1}{2}W$	$\pm 10\%$
						R605	100k	fixed	comp	$\frac{1}{2}W$	$\pm 10\%$
R353	47k	fixed	comp	1W	$\pm 10\%$	R606	100k	fixed	comp	$\frac{1}{2}W$	$\pm 10\%$
R354	50k	var	comp	2W	$\pm 20\%$						
R355	68k	fixed	comp	2W	$\pm 10\%$	R700	100 Ω	fixed	comp	1W	$\pm 5\%$
R356	27k	fixed	comp	$\frac{1}{2}W$	$\pm 10\%$	R701	160 Ω	fixed	comp	2W	$\pm 5\%$
						R702	68 Ω	fixed	comp	1W	$\pm 5\%$
R360	330 Ω	fixed	comp	$\frac{1}{2}W$	$\pm 10\%$	R703	68 Ω	fixed	comp	1W	$\pm 5\%$
R361	330 Ω	fixed	comp	$\frac{1}{2}W$	$\pm 10\%$						
						R800	3ea270 Ω	fixed	MF	8W	$\pm 5\%$
R370	330 Ω	fixed	comp	$\frac{1}{2}W$	$\pm 10\%$	R801	3ea 75 Ω	fixed	MF	6W	$\pm 5\%$
R400	22k	fixed	comp	2W	$\pm 10\%$	R810	2ea 70 Ω	fixed	MF	6W	$\pm 5\%$
R401	5k	var	comp	2W	$\pm 20\%$	R811	2ea 52 Ω	fixed	MF	6W	$\pm 5\%$
R402	3.3k	fixed	comp	2W	$\pm 10\%$	R812	26 Ω	fixed	MF	6W	$\pm 5\%$
R450	100 Ω	fixed	comp	$\frac{1}{2}W$	$\pm 10\%$	R820	35 Ω	fixed	MF	3W	$\pm 5\%$
R451	22 Ω	fixed	comp	$\frac{1}{2}W$	$\pm 10\%$	R821	26 Ω	fixed	MF	3W	$\pm 5\%$
R452	100 Ω	fixed	comp	$\frac{1}{2}W$	$\pm 10\%$	R822	26 Ω	fixed	MF	3W	$\pm 5\%$
R460	100 Ω	fixed	comp	$\frac{1}{2}W$	$\pm 10\%$	R830	36 Ω	fixed	comp	$\frac{1}{2}W$	$\pm 5\%$
R461	22 Ω	fixed	comp	$\frac{1}{2}W$	$\pm 10\%$	R831	27 Ω	fixed	comp	$\frac{1}{2}W$	$\pm 5\%$
R462	100 Ω	fixed	comp	$\frac{1}{2}W$	$\pm 10\%$	R832	27 Ω	fixed	comp	$\frac{1}{2}W$	$\pm 5\%$
R470	1meg	fixed	comp	$\frac{1}{2}W$	$\pm 10\%$	R840	36 Ω	fixed	comp	$\frac{1}{2}W$	$\pm 5\%$
R471	1.5k	fixed	comp	$\frac{1}{2}W$	$\pm 10\%$	R841	27 Ω	fixed	comp	$\frac{1}{2}W$	$\pm 5\%$
R472	4.7k	fixed	comp	2W	$\pm 10\%$	R842	27 Ω	fixed	comp	$\frac{1}{2}W$	$\pm 5\%$
R473	5k	var	comp	2W	$\pm 20\%$						
R474	3.3k	fixed	comp	2W	$\pm 10\%$	R850	36 Ω	fixed	comp	$\frac{1}{2}W$	$\pm 5\%$
						R851	27 Ω	fixed	comp	$\frac{1}{2}W$	$\pm 5\%$
R500	3k	fixed	WW	10W	$\pm 10\%$	R852	27 Ω	fixed	comp	$\frac{1}{2}W$	$\pm 5\%$
R501	100k	fixed	comp	$\frac{1}{2}W$	$\pm 10\%$						
R502	150k	fixed	comp	1W	$\pm 10\%$						
R503	.75 Ω	fixed	WW	4W	$\pm 5\%$						
R510	10 Ω	fixed	comp	$\frac{1}{2}W$	$\pm 10\%$						
R511	10 Ω	fixed	comp	$\frac{1}{2}W$	$\pm 10\%$						
R512	33k	fixed	comp	$\frac{1}{2}W$	$\pm 10\%$						
R513	50k	var	comp	2W	$\pm 20\%$						
R514	68k	fixed	comp	1W	$\pm 10\%$						
R515	220k	fixed	comp	$\frac{1}{2}W$	$\pm 5\%$						
R520	220k	fixed	comp	$\frac{1}{2}W$	$\pm 10\%$						
R521	470k	fixed	comp	$\frac{1}{2}W$	$\pm 10\%$						
R522	150k	fixed	comp	$\frac{1}{2}W$	$\pm 5\%$						
R530	22k	fixed	comp	2W	$\pm 10\%$						
R531	270k	fixed	comp	$\frac{1}{2}W$	$\pm 5\%$						
R532	250k	var	comp	2W	$\pm 20\%$						
R534	680k	fixed	comp	$\frac{1}{2}W$	$\pm 10\%$						
R535	120k	fixed	comp	$\frac{1}{2}W$	$\pm 10\%$						
R536	100k	fixed	comp	$\frac{1}{2}W$	$\pm 10\%$						

SWITCHES

S110	B7-A-506	RUTHERFORD
S200	B7-A-507	RUTHERFORD
S300	B7-A-507	RUTHERFORD
S450	B7-A-505	RUTHERFORD
S500	SPST	"ON-OFF" TOGGLE
S800	300-A-502	RUTHERFORD

TRANSFORMERS

			T260	B7-504	RUTHERFORD
			T350	B7-502	RUTHERFORD
T120	B7-501	RUTHERFORD	T360	B7-502	RUTHERFORD
			T361	B7-504	RUTHERFORD
T210	B7-501	RUTHERFORD			
			T500	B7-D-500	RUTHERFORD
T250	B7-502	RUTHERFORD			
T361	B7-504	RUTHERFORD	T600	SO-4	UNITED XFMR CO.

REPLACEMENT OF COMPONENTS

In the event that component replacement becomes necessary, it is strongly recommended, in order to avoid considerable delay and unnecessary expense, that such replacement components be purchased from your local electronics supplier. A large majority of the components used in the instrument are standard electronic components and little difficulty should be encountered in replacing them.

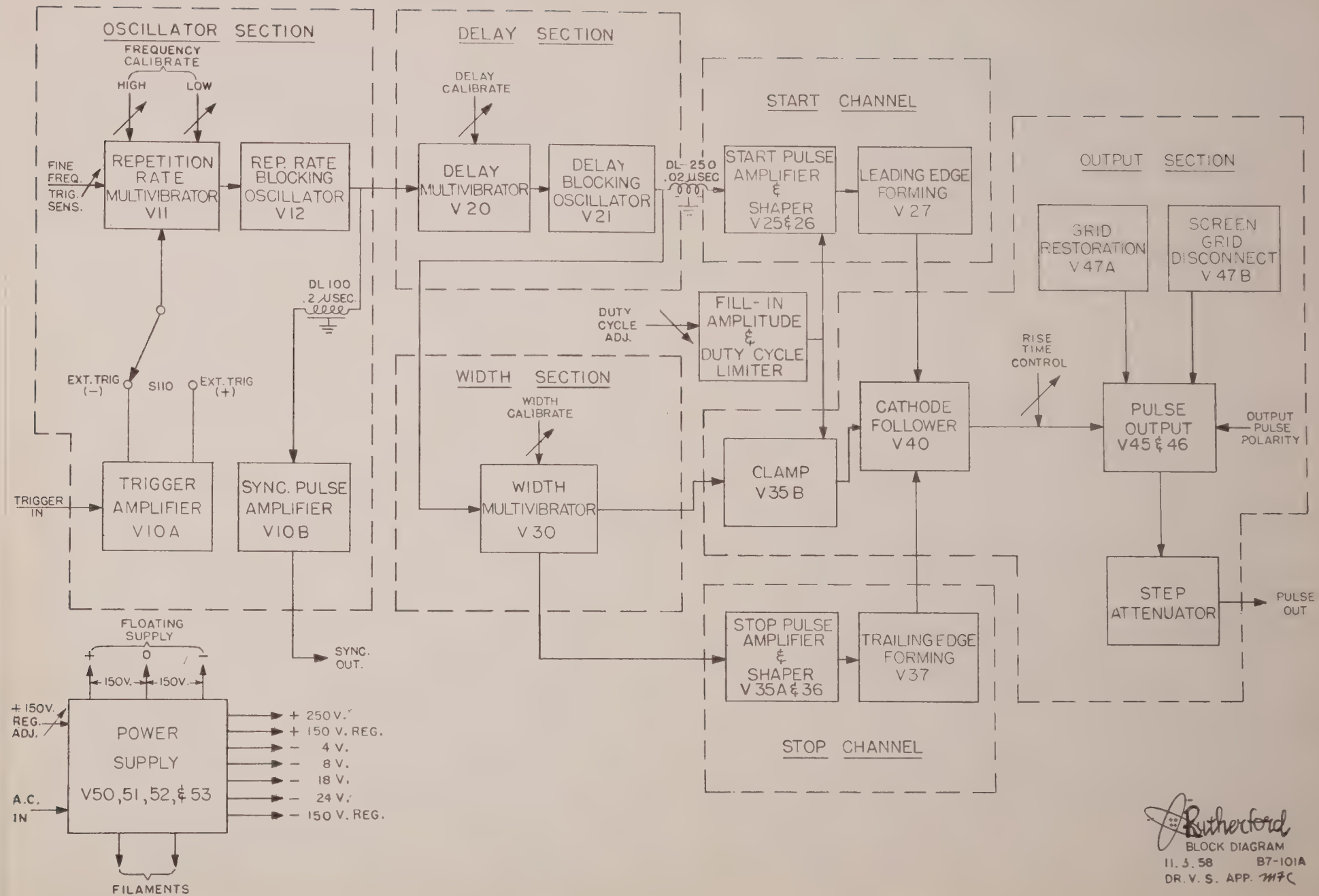
Certain components, manufactured to RUTHERFORD ELECTRONICS CO.'S specifications, may not be readily available through local suppliers. These components should be ordered from our factory.

WARRANTY

RUTHERFORD ELECTRONICS CO. guarantees to the original purchaser for a period of one (1) year, EXCEPT vacuum tubes which are guaranteed for ninety (90) days, that this instrument is free from defects in material and workmanship. Our liability is limited to repair or replacement of this instrument, or any part thereof, providing failure is not due to misuse or abnormal conditions.

In order to receive service under this warranty, promptly advise the factory of all details pertinent to failure of the instrument. Replacement parts will be shipped via air transportation if requested, prepaid to any point in the continental United States. Should it be desirable to return the instrument, ship it prepaid to the factory, and it will be serviced as required and returned via surface transportation, prepaid.

Service required after the expiration of warranty, or because of misuse or abnormal conditions will be billed at cost.

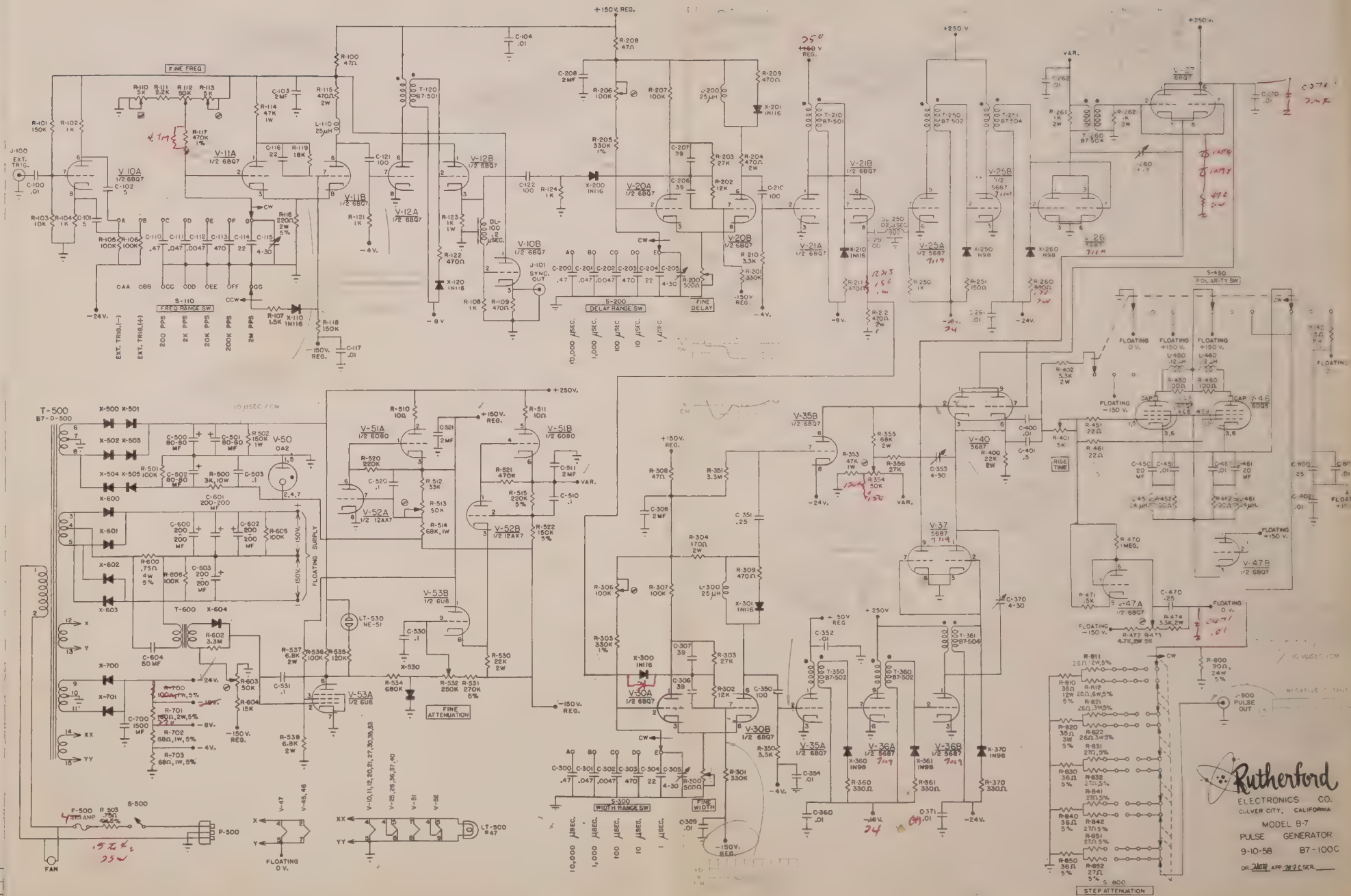


A	11 24 58	192	Over 1
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NOTES

UNLESS OTHERWISE SPECIFIED

1. ALL FIXED RESISTORS ARE 1/2 WATT, $\pm 10\%$.
2. ALL CAPACITOR VALUES ONE (1) OR LESS ARE IN MICROFARADS, THOSE GREATER THAN ONE (1) ARE IN MICROMICROFARADS.
3. ALL VARIABLE RESISTORS ARE 2W, $\pm 20\%$.



Rutherford
ELECTRONICS CO.
CULVER CITY, CALIFORNIA
MODEL B-7
PULSE GENERATOR
9-10-58 B7-100C
DR. 240 APP. 242 SER.

Rutherford ELECTRONICS CO.

8944 LINDBLADE STREET • CULVER CITY, CALIFORNIA

TELEPHONES: UPTON 0-7393 • VERMONT 9-0116

SPECIFICATIONS B-5A

MAIN PULSE:

PULSE WIDTH: continuously variable from .02 microsecond to 12.5 microseconds (duty factor limited to 20%) in four ranges:

.02 to .1 microsecond

.1 to .5 microsecond

.5 to 2.5 microseconds

2.5 to 12.5 microseconds

AMPLITUDE: 40 volts positive, 45 volts negative.

ATTENUATOR: 60 db in 1/2 db steps.

RISE AND FALL TIME: less than 8 millimicroseconds.

POLARITY: both positive and negative pulses simultaneously available.

OUTPUT IMPEDANCE: 185 ohms (the instrument must be terminated for proper pulse shape).

OUTPUT DECAY CONSTANT: 750 microseconds when terminated in 185 ohms.

SYNCHRONIZING PULSE OUT: 10 volts, positive.

RISE TIME: less than .02 microsecond.

WIDTH: .03 microsecond.

EXTERNAL TRIGGER:

Pulse Required: 10 volts minimum with rise time less than .05 microsecond.

PULSE REPETITION RATE:

Continuously variable from 1 cycle/sec to 10 mc/sec in seven ranges:

1 c to 10 c

10 c to 100 c

100 c to 1 kc

1 kc to 100 kc

10 kc to 100 kc

100 kc to 1 mc

1 mc to 10 mc

DELAY:

A fixed delay of .1 microsecond occurs between the synchronizing pulse out and the main pulse.

ELECTRONIC PULSE DELAY: can be set to zero or is continuously variable from 0.030 μ sec. to 500 μ sec. in 5 ranges.

Note: Pulse delay is limited to approximately 20% of the pulse spacing.

POWER REQUIRED:

105-125 volts, 50-60 cycles, 600 watts.

CONNECTORS:

Sync. Pulse Out—type BNC.

External Trigger—type BNC.

Main Pulse—type C.

DIMENSIONS: 23" high, 23" wide, 16" deep.

WEIGHT: 110 pounds.

ACCESSORIES SUPPLIED

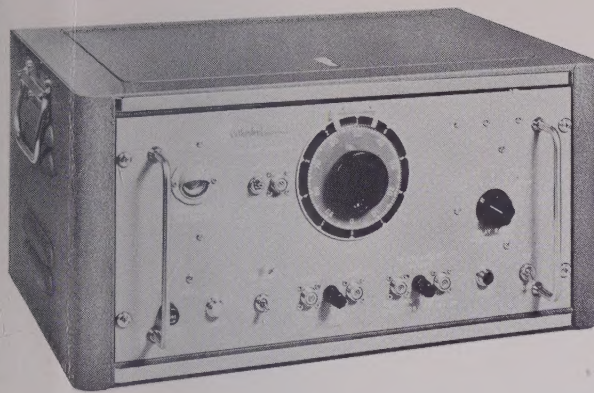
1 unit extension cable.

1 5-ft. output cable (type RG 114/U)

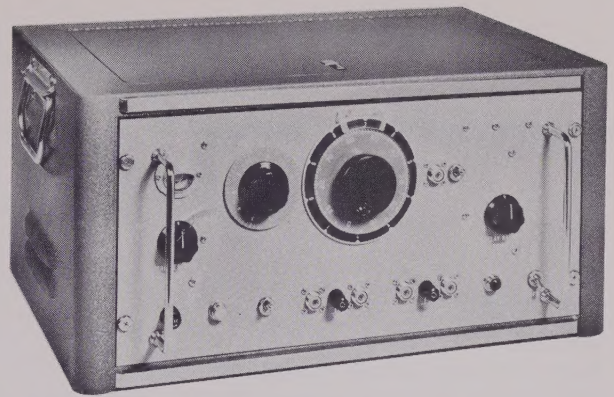
1 185 ohm non-inductive resistor.

1 185 ohm termination assembly.

1 instruction manual.



MODEL A-2



MODEL A-4

TIME DELAY GENERATORS

APPLICATIONS OF RUTHERFORD MODEL A-2 DELAY GENERATOR

Calibration of synchrosopes...measurement of radar range...
simulation of radar range...simulation of moving targets (with
auxiliary equipment)...delaying synchroscope sweeps...produc-
tion of accurately spaced pulses for biological investigations...
measurement of waveform timing...measurement of time delays
...measurement of pulse width...to replace internal delay cir-
cuits of pulse generators when a more accurate delay is required
...testing the resolving time of counters (with auxiliary equipment)
...measurement of sonar range

Rutherford ELECTRONICS CO.

8944 LINDBLADE STREET
CULVER CITY, CALIFORNIA
TELEPHONE UPton 0-7393

SPECIFICATIONS

MODEL A-2

DELAY RANGES:

.8 to 100,000 microseconds. In five decade ranges

INCREMENTAL DELAY:

Limited by the resolution of the helical potentiometer control
to 1/9800 of full scale.

JITTER:

.01 microsecond or .008%, whichever is greater.

ACCURACY:

After calibration: $\pm 1\%$ of full scale.

Long term: $\pm 1\%$ of full scale.

LINEARITY:

.3% or better between .1 full scale and full scale (except on
.8 to 10 microsecond range).

INPUT:

Amplitude:

15 volts min., 60 volts max. pulse.

30 volts RMS 100 cycle sine wave min., 60 volts max.

Blocking Condenser:

for 400 volts.

Impedance:

20 mmfd and 470,000 ohms.

DIAL CALIBRATION:

1000 divisions, each approximately $\frac{1}{8}$ inch wide.



OUTPUT PULSES:

BLOCKING OSCILLATOR

Width: .5 microsecond wide between 10% points.

Rise Time: .1 microsecond between 10% and 90% points.

Output Impedance: 100 ohms (.01 mfd blocking condenser).

Amplitude: 50 volts.

MULTIVIBRATOR

Widths approximately as per table below. For presentation on synchroscope.

Range	Width
10 microseconds	5 microseconds
100 microseconds	10 microseconds
1,000 microseconds	30 microseconds
10,000 microseconds	100 microseconds
100,000 microseconds	400 microseconds

Output Impedance: 500 ohms (.1 mfd blocking condenser).

Amplitude: 35 volts.

EXTERNAL DELAY VOLTAGE:

150 to 50 volts... zero to full delay.

REPETITION RATE EFFECTS:

The error introduced by repetition rate changes is a function of the percent duty factor. A representative table of duty factor effects for 1,000 microsecond scale is shown below:

Duty Factor	Error
.5%	0 (reference)
5%	.1%
50%	.4%
90%	3.2%
95%	5%
97%	5.5%

The duty factor must be limited to allow at least 3 microseconds recovery time.

EFFECT OF LINE VOLTAGE VARIATIONS:

Variations from 105 volts to 125 volts changes the delay by .15%.

INDICATING LAMPS:

Pilot light (on-off): Blown fuse.

INDICATOR TUBE:

"Magic Eye" tube type 6E5 to indicate coincidence of delayed pulse and calibrating pulse.

POWER:

105-125 volts, 50-60 cycles, 140 watts.

SIZE:

Mounts on standard 8 $\frac{3}{4}$ " x 19" relay rack panel. Chassis is 13" deep. With dust cover is 10 $\frac{1}{2}$ " high, 22 $\frac{1}{4}$ " wide and 14 $\frac{7}{8}$ " deep overall, including front panel protective handles.

WEIGHT: 5.3 pounds

ACCESSORIES SUPPLIED:

Instruction book

PRICE:

\$750.00 F.O.B. Culver City.

SPECIFICATIONS

MODEL A-4

Basically the same as Model A-2 except as follows:

DELAY RANGES:

.00001 to 10 seconds. In five decade ranges

INTERNAL OSCILLATOR:

RANGES:

1,000 cps to 100 cps
100 cps to 10 cps
10 cps to 1 cps
1 cps to .1 cps

MULTIVIBRATOR

Widths approximately as per table below. For presentation on synchroscope.

Range	Width
.001 second	30 microseconds
.01 second	100 microseconds
.1 second	500 microseconds
1. second	5,000 microseconds
10. second	50,000 microseconds

Output Impedance: 500 ohms (1 mfd blocking condenser).

Amplitude: 35 volts.

TRIGGER

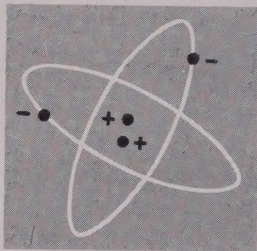
Same as blocking oscillator.

PRICE:

\$875.00 F.O.B. Culver City.

Other Rutherford instruments you might find useful in your laboratory:

1. High Repetition Rate Pulse Generators
2. Precision Time Delay Generators
3. General Purpose Pulse Generators
4. Versatile Modular Construction Pulse Generators
5. Special Design Pulse Instrumentation
6. 10 Megacycle Pulse Generators
7. Highly Accurate Pulse Generators
8. Variable Rise Time Generators
9. Low Jitter Pulse Generators
10. Multiple Pulse and Pulse Code Generators
11. Pulse Systems



Rutherford
ELECTRONICS CO.